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## EDUCATIONAL VALUES IN MATHEMATICAL TEACHING.

BY H. E. HAWKES.

Any member of the teaching profession—a profession which is closely bound by the demands of routine work—is likely to be tempted either to assume radical and extreme views, or else to become stereotyped and to follow tradition. Just which direction any individual will follow is largely a matter of temperament. But either extreme usually betokens a failure to see things in their true relations, and in the proper perspective.

It seems to me that meetings of associations like this offer admirable opportunity to look at some of the larger aspects of our professional responsibility, to attempt to place our various methods and aims in some perspective, and to determine some principles of procedure armed with which we may return to our routine of details with fresh enthusiasm and renewed confidence in the worth of our labors.

During recent years much thought and experiment has been brought to bear on the attempt to determine some norm or standard in terms of which the various subjects of study in our schools may be compared and possibly measured. One important phase of the problem, though far from being completely worked out, serves to indicate results which may be stated roughly as follows:

In the study of any subject, as for instance, mathematics, we are first met by a large number of specific results in the nature of facts acquired, theorems proved, principles mastered, which distinguish it from other subjects. This category of results I will call the *subject matter*.

These facts are acquired and elaborated by the use of certain methods involving mental processes which are quite distinct from the subject matter itself. In this second category, which we may call *mental processes*, we place memory, the power of analysis, generalization, reasoning and the like.

As a result of this working over and mastery of the subject,

qualities of a quite different character are evoked which we may call *moral qualities*, such as perseverance, patience, reliability, response to duty, appreciation of the true, the good and the beautiful.

Of course these three categories cannot be defined with precision, and very likely no two men would agree exactly as to their content, but I think it is clear that they form a convenient way of dividing into segments what may be a continuum of intellectual experience.

Now it is claimed, and indeed it seems quite reasonable to anyone on a moment's reflection, that the contents of the first category are but slightly transferable from the field in which they were acquired into other fields. For instance, the facts about the angles of triangles which are learned in geometry are not carried over spontaneously and easily even into so closely allied a field as that of physics. In a certain sense, then, the subject matter is of narrow educational value. Its significance is intensive rather than extensive.

The second category is transferred quite easily. The rational processes, for example, which the boy learns to use in his mathematics plays him in good stead when, in the law school, he is trying to follow the effects of legal principles. The relation between the educational content of the first two categories was well expressed some years ago by President Hadley of Yale when he said "the value of an education largely consists in studying facts which will not be used in after life by methods which will be used."

The third division of moral or spiritual qualities are of indefinitely wide transferability, and in this sense constitute the elements of most extensive educational value in the study of any subject.

Let me hasten to add that the acquirement of the second and the third class of results is impossible without the first. No boy can get the mental and moral value which the study of mathematics should afford merely by hearing someone talk about it. Only by steady and hard work with the details of the subject will the richer benefits be derived. Excepting for the man who will occasionally use mathematics in his professional career, the subject matter in and of itself is of little importance. It is a

(To be continued.)